PCS®2

Procedure Guide

ARTEL®

25 Bradley Drive
Westbrook, Maine USA 04092-2013
tel: 207-854-0860, toll free: 1-888-406-3463
fax: 207-854-0867
email: orders@artel-usa.com
email: support@artel-usa.com
web: www.artel-usa.com

15A2135L

Note: ***This Guide applies to PCS® instruments with firmware versions 7A2.XXX, where "XXX" represents a three digit number between 001 and 299. Changes for later versions may be described in addenda and inserted following this page.***

Document Number & Revision: 15A2135L
Document Revision Date: July 2011

Copyright © 2011 Artel, Inc.

PCS® technology is protected by the following patents:
USA: 7791716, 7772008, 5492673, 5298978
Europe: EP0711404, EP0628157
Japan: 2520852

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America.

Artel, the Artel logo and PCS are registered trademarks of Artel, Inc., Westbrook, Maine.

Artel
25 Bradley Drive
Westbrook, ME 04092-2013
U.S.A.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 INSTRUMENT PREPARATION

2.1 Location 3
2.2 Set-up and Cabling Illustration 3
2.3 Cabling Procedures 4
2.4 Seiko Printer 4
2.5 RS232 Port 5

3.0 REAGENT KIT

3.1 Contents of Standard Reagent Kit 7
3.2 Cleaning of PCS Vials 8
3.3 Storage 8
3.4 Disposal 8
3.5 Ordering 8

4.0 OPERATION

4.1 Instrument Keys and Operating Functions 9
4.2 Initial Power-On Sequence 10
4.3 Starting Pipette Calibration 10
4.4 Inserting the Blank Vial 13
4.5 Entering Pipette ID Number 14
4.6 Entering Pipette Volume 14
4.7 Pipetting Sample Solution 15
4.8 Pipetting Additional Samples 17
4.9 Eliminating Sample Readings and Reprinting Results 17
4.10 Performing Additional Calibrations In One Vial 18
4.11 Continuing a Calibration Run with Another Vial 20
4.12 Calibrating an Adjustable Volume Pipette at Multiple Volumes 20
4.13 Suggested Initial Tolerance Limits 21

5.0 INSTRUMENT CAL A AND CALIBRATION

5.1 Instrument CAL A 23
5.2 Instrument Calibration 23
5.3 Instrument Calibration Summary 27

TABLE OF CONTENTS

6.0 INSTRUMENT SETUP

6.1 Instrument Setup Menu 29
6.2 Setting Date 30
6.3 Setting Time 30
6.4 Choosing Date Format 31
6.5 Customizing the Printout Header 31
6.6 Computer Link Flags 32
6.7 Serial Data Output (Data Collect Flag) 33
6.8 Choose Nomenclature 34
6.9 Display Uncertainty 35
6.10 Signature Block 36

7.0 TROUBLESHOOTING

7.1 Instrument Diagnostics Menu 37
7.2 Troubleshooting Guide 40

8.0 SYSTEM MAINTENANCE

8.1 Preventive Maintenance 43
8.2 Instrument Calibration 43
8.3 Removal of Rear Access Cover 43
8.4 Maintenance Log Sheet 45

9.0 WARRANTY AND SERVICE

9.1 Warranty Statement 47
9.2 Return and Repair 47

APPENDICES

Specifications ..... A
PCS Printouts ..... B
Formulas Used to Calculate Group Statistics C
ASCII Character Set ..... D
Alphabetic Character Entry ..... E
Number of Samples Per Vial ..... F
Consumables ..... G

1.0 INTRODUCTION

Accuracy and precision in volumetric measurement and transfer are essential to all laboratories concerned with maintaining quality and productivity. Pipette performance can vary significantly over time, and conformance to specified accuracy and precision levels cannot be taken for granted.

Employing a colorimetric method and a high performance photometer, the PCS® allows the user to accurately, precisely, quickly, and easily measure the dispensed volume from any pipette (from 0.1 µL to 5000 µL). Measurements made with the Artel Pipette Calibration System (PCS®) are traceable to the International System of Units (SI) through reference standards developed and maintained by the National Institute of Standards and Technology, USA (NIST).

The volume of liquid delivered is immediately calculated and displayed for each data point. A Printout is generated displaying the volume of each sample and the group statistics. The Printout includes such information as pipette ID, operator ID, time, temperature, and date to assist with effective record keeping.

Additionally, by providing immediate feedback to the user, the PCS is an effective tool for improving pipetting technique.

With a minimal amount of training an operator can calibrate pipettes both when and where needed, improving workflow, quality, and efficiency in the laboratory.

This manual provides step-by-step instructions for all major operations to assist the user to be up and running more quickly.

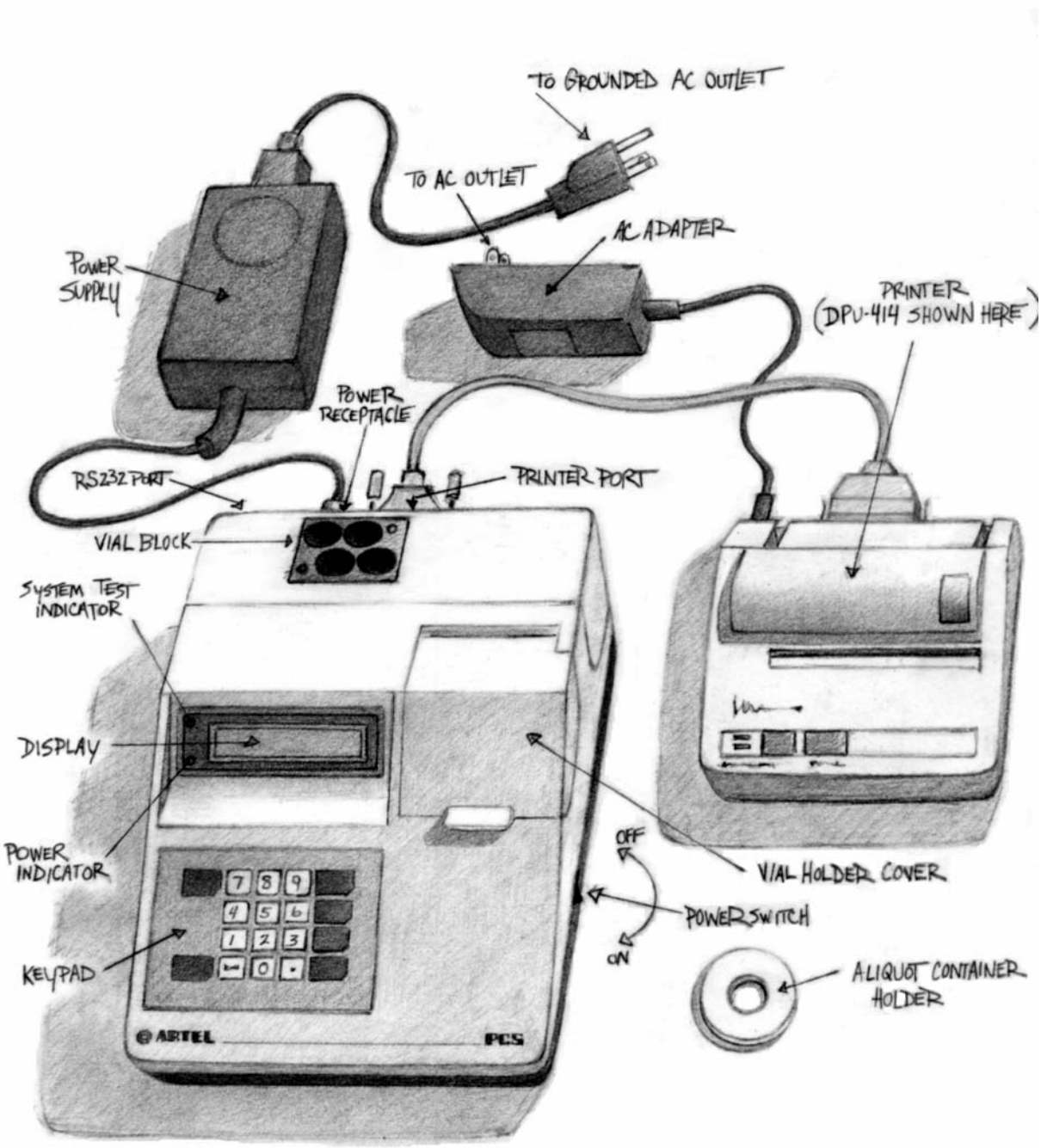
This Page Intentionally Left Blank

2.0 INSTRUMENT PREPARATION

2.1 Location

The Instrument should be located in an area that is out of direct sunlight and away from local heat sources (e.g. an oven or heat vent).

2.2 Set-up and Cabling Illustration



2.3 Cabling Procedures

2.3.1 Connecting the Instrument to Power

The Instrument requires a three-prong electrical receptacle supplying single-phase power from 100-250 VAC, 50/60 Hz in which to plug the Power Supply. The same power source should be used for the Instrument and the Printer. This power line should be free from transients or voltage variations caused by other equipment such as water baths or refrigerators.

Make sure that the Instrument Power Switch is off. Plug one end of the Power Cord into the Power Supply and the other end of the Power Cord into a grounded AC outlet. Insert the remaining plug into the power receptacle found at the rear of the Instrument.

IMPORTANT	Ensure that all above connections are firmly in place.

2.3.2 Connecting the Seiko Printer to Power

NOTE: If the STAR Dot Matrix Printer is being used, please refer to the STAR Printer User's Manual for printer connection and operation.

Plug the Printer AC adapter into an appropriate receptacle. Plug the remaining end of the adapter into the power receptacle located at the rear of the Printer.

2.3.3 Connecting the Printer to the Instrument

Make sure the Instrument and Printer are turned off. Plug one end of the Printer cable into the Printer and the other into the Instrument.

IMPORTANT	When the Instrument and Printer are connected, the Instrument must be powered on to operate the Printer.

2.4 Seiko Printer

2.4.1 Controls and Indicators:

Power Switch. When slid to the ON position, power is supplied to the Printer and the POWER and ON LINE indicators illuminate. When there is no paper loaded, the OFF LINE indicator flashes.

Paper Feed Switch. Pressing this switch feeds the paper continuously. Paper feed will work only when the OFF LINE indicator illuminates or flashes.

On Line/Off Line/Paper End Switch. Pressing this switch shifts the Printer from ON LINE to OFF LINE and vice versa. When ON LINE, the Printer is ready to receive instructions from the Instrument. The Printer cannot be turned ON LINE if paper is not loaded.

2.4.2 Loading Printer Paper

Turn the Power Switch to the ON position.

Open the paper cover located on the top right hand side of the Printer.

Cut the end of the paper roll cleanly and squarely.

Insert the end of the paper into the inlet at the bottom of the paper holder until the auto-loader catches it and feeds it through. The outside of the roll is the printable surface for the thermal paper roll.

Close the paper cover.

NOTE: A red line will appear on both sides of the paper when the paper roll nears depletion. This indicates that the paper roll should be changed.

2.4.3 Preparing the Printer for Pipette Calibration

Once the paper roll is in place, the Instrument and the Printer can be turned ON. When the ON LINE light is green, the printer is ready for operation.

NOTE: Refer to the printer operation manual for more detailed information.

2.5 RS232 Port

Refer to Section 6.7, “Serial Data Output,” for information on use of the RS232 port.

This Page Intentionally Left Blank

3.0 REAGENT KIT

3.1 Contents of Standard Reagent Kit

Blank Reagent Vials:

(12) Prefilled with Blank Reagent.

Sample Solutions:

(1) Range 1: For pipette volumes 200 to 5000 µL

(1) Range 2: For pipette volumes 50 to 199 µL

(1) Range 3: For pipette volumes 10 to 49 µL

(1) Range 4: For pipette volumes 2 to 9 µL

NOTE: Range 5 for pipette volumes 0.5 to 1.9 µL, and Range 6 for pipette volumes 0.1 to 0.49 µL, are sold separately.

Sample Aliquot Containers:

(12) Used to contain an aliquot of Sample Solution.

Transfer Pipettes:

(12) Used to transfer an aliquot of Sample Solution into a Sample Aliquot Container.

Calibration Standard:

(1) CAL A used for zeroing the Instrument daily.

Kit Inserts:

(1) Declaration of Traceability
(1) Lot Code Card (Refer to Section 4.3, “Starting Pipette Calibration.”)

3.2 Cleaning of PCS Vials

To ensure that accurate and precise results are obtained during pipette and PCS Instrument calibration, all vials should be free from fingerprints and smudges prior to placement into the Vial Block to equilibrate. Fingerprints and smudges that fall within the optical path will introduce errors and cause inaccurate readings.

All PCS vials are cleaned and inspected prior to shipment. However, the lower portion of the vials should be cleaned prior to use.

Recommended vial cleaning procedure:

3.2.1 Holding the vial by the cap, immerse the lower portion of the vial (about 2.5 cm) into clean isopropyl alcohol.

3.2.2 Remove the vial from the alcohol and while wearing gloves gently wipe the lower portion of the vial by rotating the vial against a lint free wipe.

3.3 Storage

The Reagent Kit should be stored at room temperature (18 °C to 28 °C). Avoid storage temperatures exceeding 32 °C. Kit components should be stored in the dark to the extent practical.

NOTE: Reagents received frozen should be brought to room temperature and gently inverted.

3.4 Disposal

Refer to Material Safety Data Sheet (MSDS) for proper disposal. All PCS Reagents are non-hazardous and aqueous-based.

3.5 Ordering

To place an order or request a product list, please contact Customer Service at:

Local: 207-854-0860
Toll Free: 888-406-3463
Fax: 207-854-0867
Email: orders@artel-usa.com

4.0 OPERATION

4.1 Instrument Keys and Operating Functions

YES	Starts a procedure or is used as a positive response to a question.
ENTER	Enters a numerical value such as the pipette ID number or volume. It also can be used when checking adjustable volume pipettes to signify a change to a new volume.
MENU SCROLL	Used to view the next question or a different question.
NO	Used as a negative response to a question.
	Enters a decimal point, which is used when entering lot codes.
END OF RUN	Terminates a pipette calibration run. Group statistics for data collected up to that point of the procedure will be printed.
CLEAR	Clears the data entry window or corrects the most recent invalid entry.
RESET	Halts the procedure and returns the system to the prompt: **Main Menu** **Pipette Calibration?** Ends the calibration and the Blank Vial in use.

4.2 Initial Power-On Sequence

4.2.1 Turn on the Instrument and the Printer. Be sure the Printer is ON LINE.

4.2.2 Before performing this procedure ensure that the Reagent Kit is at the same temperature as the Instrument.

NOTE: If the kit has been moved from another location, depending on the difference in temperature between the two locations, allow time for equilibration.

CAL A and Blank Vials should be loaded into the Vial Block at least 15 minutes prior to their use. Four vials at a time can be loaded into the Vial Block. Inspect vials for smudges. If cleaning is necessary, refer to Section 3.2, “Cleaning of PCS Vials.”

4.2.3 Upon power-on, the Instrument will perform a system test. The following prompt will be displayed:

Main Menu **Pipette Calibration?**

NOTE: To check the date and time, and to edit the header information on the Printout, refer to Section 6.0, “Instrument Setup.”

4.3 Starting Pipette Calibration

4.3.1 At the prompt:

Main Menu **Pipette Calibration?**

Press **YES** to begin the pipette calibration procedure.

The instrument will then check the temperature, and if it is outside the specified range for proper operation (18 °C to 28 °C), the following prompt will be displayed:

Temp. out of range **Continue? (Y/N)**

If **NO** is pressed, the following prompt will be displayed:

Main Menu **Pipette Calibration?**

If **YES** is pressed to continue with the calibration, there is no certainty that the results the PCS obtains will meet the system specifications.

The display will prompt to enter the Lot Code:

Enter Reagent Lot **Code: __**

4.3.2 Enter the Lot Code. The Lot Code is shown on the Reagent Vials, Reagent Kit insert, and on the exterior of the Reagent Kit box. The Instrument maintains a library of up to 6 previously entered Lot Codes. If this Lot Code matches one previously entered, proceed to Section 4.3.3.

If the Lot Code does not match, the display will prompt:

Rgt Lot Code XXXXX **New Lot? (Y/N)**

If the Lot Code was entered incorrectly, press **NO** and enter the correct Lot Code.

Press **YES** if entering a new Lot Code. The Group Numbers found on the correct side of the Lot Code Card for the instrument type will need to be entered. Press **ENTER** after entry of each group of digits. At the next prompt, enter the month and year of the expiration date of the Reagent Kit as indicated on the Lot Code Card in the format mmyy (e.g. 0811 for August 2011).

The following prompt will be displayed:

Lot Code: XXXXX **Correct? (Y/N)**

Press **YES** to confirm.

4.3.3 The Instrument will perform a brief self-calibration. The following prompt will be displayed:

Self-Calibration **Please Wait**

Followed by:

Insert **CAL A Vial**

IMPORTANT	Use the CAL A from the Reagent Kit in use, not the CAL A from the Instrument Calibrator Kit. The label for this vial should face toward the front of the Instrument, with the vertical line on the vial facing forward.

Remove the CAL A Calibration Standard from the Vial Block.

4.3.4 Open the Vial Holder Cover and insert CAL A into the Vial Holder, pressing it down until it meets the bottom of the Vial Holder. Never remove the cap of the CAL A Calibration Standard.

The following prompt will be displayed:

Please **Close the Cover**

4.3.5 Close the Cover.

The Instrument will then perform a Zero Check while displaying:

PCS Zero Check **Please Wait**

The following prompt will be displayed:

Please **Remove Vial**

4.3.6 Remove CAL A and place it into the Reagent Kit for future use.

The following prompt will be displayed:

Remove Cap and Insert Blank

4.4 Inserting the Blank Vial

IMPORTANT Blank Reagent Vials must be handled with care.

- Each vial contains a predetermined amount of liquid and spillage will reduce accuracy.
- The lower portion of the Blank Vial is a part of the optical path and smudges will decrease the accuracy of the results. Touching this region should be avoided.
- To ensure a consistent optical path, once the Blank Reagent Vial has been inserted into the Instrument it must not be turned, moved or removed until the calibration procedure is completed for all pipettes to be calibrated using that vial.

4.4.1 Remove a Blank Reagent Vial from the Vial Block. The Blank Reagent is light blue in color.

4.4.2 Remove the cap, open the Vial Holder Cover and insert the Blank Reagent Vial into the Vial Holder, pressing it down until it contacts the bottom of the Vial Holder.

The following prompt will be displayed:

Please Close the Cover

4.4.3 Close the Vial Holder Cover. The Instrument will read the Blank while displaying:

Reading Blank Please Wait

After the Blank reading is complete, the next prompt will instruct to enter an Operator ID:

Enter Operator ID: _

Enter a number (not exceeding 20 digits) identifying the operator for this calibration. This number appears on the Printout. For alphabetic character entry, see Appendix E.

If the ID is entered incorrectly, press **CLEAR** and enter the correct ID.

The next prompt will instruct to enter the Pipette ID:

Enter Pipette ID:
__

4.5 Entering Pipette ID Number

At the prompt:

Enter Pipette ID:
__

Key in the pipette ID (not exceeding 20 digits) and press **ENTER**. For alphabetic character entry, see Appendix E. This ID will be printed on the PCS Printout for pipette cross-referencing, and as a hard copy record.

The Instrument will print the information just entered and display:

***** Printing *** Please Wait**

Followed by:

Enter Pipette Volume: _ µL

4.6 Entering Pipette Volume

Enter the volume (in microliters) to be dispensed, and press **ENTER**. The **CLEAR** key can be used to correct an entry error prior to pressing the **ENTER** key.

NOTE: This volume must be entered in microliters ranging from 0.1 µL through 5000 µL.

The number of samples that can be added at this pipette volume in this vial will be displayed:

XX Left this Vial **Proceed? (Yes/No)**

Press **YES**. The following prompt will be displayed:

Range X **Please Wait**

The Instrument will take a final Blank reading, and then prompt:

Range X **Pipette Sample #1**

4.7 Pipetting Sample Solution

NOTE: The number of data points that are collected to calibrate a pipette depends on the requirements of the laboratory and its calibration policy. Additionally, the technique used to check the pipettes should coincide with the method for its general use.

4.7.1 Locate the appropriate Sample Solution in the Reagent Kit. Mix the contents by inverting the bottle several times before removing the cap.

IMPORTANT	The proper range of Sample Solution for the pipette volume to be tested must be used. Each kit contains bottles of Sample Solution corresponding to four different pipette volume ranges. (Refer to Section 3.1, “Contents of Standard Reagent Kit.”) If the improper Sample Solution has been pipetted into a Blank Reagent Vial, the results obtained will not be valid and that vial is no longer usable and should be discarded.

4.7.2 Using a disposable Transfer Pipette, transfer an aliquot of Sample Solution into a Sample Aliquot Container. Transfer Pipettes and Sample Aliquot Containers are found in the Reagent Kit. Place the container into the Aliquot Container Holder to reduce the possibility of spillage. Place the cap lightly on the Sample Aliquot Container to avoid evaporation, and replace the cap on the Sample Solution Bottle to avoid evaporation.

Transfer only enough Sample Solution for use in half-hour increments. The total volume of Sample Solution required depends on the sample volume and the total number of data points being generated. The volume graduations on the Transfer Pipette as well as the 1 mL mark on the Sample Aliquot Container can be used as a guide.

IMPORTANT	When handling open Blank Reagent Vials and open Sample Solutions, be very careful not to spill any liquid on or along the edges of the Instrument's keypad.

When calibrating a pipette, there is an inevitable linkage between operator technique and pipette performance. For meaningful results, it is recommended that standard laboratory pipetting technique be used and that specific pipette manufacturer's instructions are followed. Using the PCS for training purposes provides the opportunity to improve technique and to optimize pipetting accuracy and precision. For additional technique instructions, contact ARTEL Technical Support, and refer to the information included in the back of the Procedure Guide.

4.7.3 Aspirate the Sample Solution from the Sample Aliquot Container with the pipette to be calibrated, using standard pipetting technique. Place the cap lightly back on the Sample Aliquot Container between samplings to avoid reagent evaporation.

4.7.4 Lift the Instrument Vial Holder Cover and dispense the Sample Solution into the Blank Reagent Vial.

IMPORTANT	The Sample Solution should be dispensed against the inside wall of the vial with the pipette tip placed above the meniscus but below the shoulder of the Blank Vial. The vortex mixing action will wash the solution from the inside wall of the vial.

4.7.5 Once the sample is dispensed, carefully withdraw the pipette and close the Vial Holder Cover.

The Instrument will then display:

Mixing Sample # 1
Please Wait

Followed by:

Reading Sample #1
Please Wait

4.8 Pipetting Additional Samples

After reading Sample #1, the Instrument will display the results of the reading, and will prompt to dispense the next sample:

Result #1 XXX.X
Pipette Sample #2

Follow the same procedure (steps 4.7.3 through 4.7.5) for Sample #2 and for each subsequent sample addition. After each subsequent sample addition, the Instrument will mix, read, and print the delivered volume.

When calibrating a fixed volume pipette and the desired number of data points for the calibration run have been collected, press **END OF RUN**. When calibrating an adjustable volume pipette at multiple volumes, press **ENTER** and see Section 4.12, “Calibrating an Adjustable Volume Pipette at Multiple Volumes.” The group statistics will be computed and the results printed.

4.9 Eliminating Sample Readings and Reprinting Results

NOTE: Conformance with regulatory or other requirements relating to the provision of sufficient justification for the elimination of data points from the statistical summary is the responsibility of the user.

If at the end of a run a second copy of the results is desired, or it is determined that a given data point can be eliminated from the statistical summary, at the prompt:

Reprint Results?
(Yes/No)

Press **YES**. If no data points need to be eliminated from the statistical summary, at the next prompt:

Delete Data Points?
(Yes/No)

Press **NO**. If a given data point from the statistical summary needs to be deleted, press **YES**. At the prompt:

Enter Pt # to Delete

Enter the Sample # of the data point to be deleted. At the prompt:

Delete More Data Points? (Yes/No)

Press **YES** to continue to delete data points. Any number of data points may be deleted. The deleted data points will be printed on the Printout, but an asterisk will appear beside them, indicating that they are not included in the statistical summary. When all desired data points are deleted, press **NO** at the prompt:

Delete More Data Points? (Yes/No)

The corrected statistics will be printed.

4.10 Performing Additional Calibrations In One Vial

The number of data points that can be collected with each Blank Vial will depend on the volume of Sample Solution added and range from 1 to a maximum of 40. (Refer to Appendix F.)

Each time a pipette calibration run is completed, the Instrument will display the remaining number of samples of the selected volume that can be dispensed into the vial. Additional calibration runs may be completed within the vial's allowed capacity. The options include performing calibrations:

(a) at the same volume
(b) at different volumes but within the same range of Sample Solution
(c) at different volumes and with a different range of Sample Solution

IMPORTANT	When calibrating pipettes from more than one range in a given vial, always use the range of Sample Solution which is appropriate for the volume of pipette being calibrated.

Following the completion and printing of the first calibration run, the following prompt will be displayed:

Another Cal w/Vial?
(Yes/No)

Press **YES** to continue. The next prompt will instruct to enter an Operator ID:

Enter Operator ID:
__

Enter a number (not exceeding 20 digits) identifying the operator for this calibration. For alphabetic character entry, see Appendix E. This number appears on the Printout.
If the ID is entered incorrectly, press **CLEAR** and enter the correct ID.

The next prompt will instruct to enter the Pipette ID:

Enter Pipette ID:
__

Continue the calibration of the second pipette from Section 4.5, “Entering Pipette ID Number.”

When the vial's maximum capacity is reached, the following prompt will be displayed:

Result #XX XXX.X __

along with the alternating prompts:

Use New Vial? (Y/N) and **End of Vial**

4.11 Continuing a Calibration Run with Another Vial

When the vial's maximum capacity is reached and additional data points are needed for the current pipette, answer **YES** to the Use New Vial? (Y/N) prompt. The Instrument will prompt to remove the current vial and insert another one. It will automatically take the Blank Vial readings and prompt for the next sample addition. This process can be repeated with subsequent vials.

By inserting vials as needed, up to 50 data points for a pipette can be generated at a single volume. All of the data points will be available for use in the statistical summary.

4.12 Calibrating an Adjustable Volume Pipette at Multiple Volumes

Calibration of adjustable volume pipettes at multiple volumes can be performed by starting at any volume within the pipette's operating range. When the desired number of samples at the first volume have been dispensed, press **ENTER**. (If the **END OF RUN** key is pressed, the Instrument will not retain the pipette ID number.) The group statistics for the first volume will be computed and the results printed. At the next prompt:

Reprint Results?
(Yes/No)

If sample readings need to be eliminated from the statistical summary, refer to Section 4.9, "Eliminating Sample Readings," for instructions. If no sample readings need to be eliminated, press **NO**. At the next prompt:

Enter Pipette
Volume: ___ µL

Enter a different volume within the pipette's range. The same pipette can be calibrated at different volumes by pressing the **ENTER** key at the completion of each volume.

IMPORTANT In some cases, the range of volumes for an adjustable volume pipette may require the use of more than one Range of Sample Solution. Special attention should be taken to observe the Sample Solution range that is noted on the display. If an improper Sample Solution has been pipetted into the Blank Reagent Vial, that vial is no longer usable and should be discarded.

After completion of the calibration run, press the **END OF RUN** key. The group statistics will be computed and the results printed. See Appendix B for an example Printout.

4.13 Suggested Initial Tolerance Limits

Based on our experience with many different makes and models of pipettes, Artel recommends the values in Table 1 as a starting point for developing achievable tolerance limits. Refer to Artel Lab Report, Issue 5, “Setting Tolerance for pipettes in the laboratory” for additional information.

Using Table 1 below, begin by choosing either the “Relative Error” or “Absolute Error” tolerance limit values. These tolerance limits reflect what is reasonably achievable in a working laboratory. They presume that the pipette is calibrated and functioning properly, is used with good quality tips, and is tested by a skilled operator. When these criteria are met, most makes and models of pipettes should test within these tolerance limits unless they are mechanically defective.

For fixed-volume pipettes, the nominal value is the fixed volume. For variable-volume pipettes, the nominal value is the largest user-selectable volume setting; e.g., a 10 to 100 µL pipette has a nominal volume of 100 µL.

The absolute error for the nominal volume applies to every selectable pipette volume; e.g., a 100 µL nominal volume yields limits of ±2.0 µL inaccuracy (mean value) and ±1.0 imprecision (STD) for all volumes. The relative error varies throughout the pipette range; e.g., for a 10 to 100 µL pipette at 100 µL the relative inaccuracy is ±2.0%. However, at 10 µL the relative inaccuracy is ±20.0%.

Notes:

a. Inaccuracy is expressed as the deviation of the mean across all samples from the set point volume. Inaccuracy can be expressed in either absolute units such as microliters, or relative units such as percent. Absolute imprecision is expressed as the standard deviation (STD) across all samples. Relative imprecision is expressed as the coefficient of variation (CV) across all samples.

b. For pipettes with nominal volumes between those provided in this table, absolute inaccuracy tolerance limits are equal to ±2.0% of the pipette’s nominal volume and the tolerance limit for absolute imprecision is 1% of the pipette’s nominal volume.

c. Relative error tolerance limits at other volume settings can be calculated by dividing the absolute tolerance limit (see Table 1) by the set point volume. Multiply the result by 100 to convert it to a percentage.

Table 1: Artel's suggested initial tolerance limits at common calibration volumes.					
Pipette Volume, µL		Relative Error		Absolute Error	
Nominal	Setting	Inaccuracy ±%	%CV	Inaccuracy ± µL	STD µL
2	2.0 1.0 0.5 0.2	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	0.04	0.02
2.5	2.5 2.0 1.0 0.5 0.25	2.0 2.5 5.0 10.0 20.0	1.0 1.3 2.5 5.0 10.0	0.05	0.025
10	10 5 2 1	2.0 4.0 10.0 20.0	1.0 2.0 5.0 10.0	0.20	0.10
20	20 10 5 2	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	0.4	0.2
50	50 25 10 5	2.0 4.0 10.0 20.0	1.0 2.0 5.0 10.0	1.0	0.5
100	100 50 25 10	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	2.0	1.0
200	200 100 50 20	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	4.0	2.0
500	500 250 50	2.0 4.0 20.0	1.0 2.0 10.0	10.0	5.0
1000	1000 500 250 100	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	20.0	10.0
2000	2000 1000 500 200	2.0 4.0 8.0 20.0	1.0 2.0 4.0 10.0	40.0	20.0
2500	2500 1000 500	2.0 5.0 10.0	1.0 2.5 5.0	50.0	25.0
5000	5000 2500 1000 500	2.0 4.0 10.0 20.0	1.0 2.0 5.0 10.0	100.0	50.0

5.0 INSTRUMENT CAL A AND CALIBRATION

5.1 Instrument CAL A

IMPORTANT	Never remove the caps of the Calibration Standards.

The CAL A from the Reagent Kit is used to zero the Instrument.

Since a small amount of drift will occur due to temperature variations, it is important to compensate for this effect by using the CAL A.

The Instrument will prompt the user when a CAL A is required, which includes:

a. Prior to the first pipette calibration after powering on the instrument.
b. If more than 8 hours have elapsed since the last CAL A.
c. If a change in temperature of ±2 °C has occurred since the last CAL A.

5.2 Instrument Calibration

At a minimum, the Instrument calibration should be checked every thirty days or prior to the next use, whichever is later. The Instrument calibration is checked using the Instrument Calibrator Kit. The Kit contains four vials (CAL A, B, C and D) with calibrator values, lot code, and expiration date, which are located on the label on the inside of the box lid. The calibrator values communicate reference information about the concentrations derived from a factory reference instrument. Calibration measurements of this factory reference instrument are traceable to the International System of Units (SI) through reference standards developed and maintained by the National Institute of Standards and Technology, USA (NIST).

The contents of the Instrument Calibrator Kit are subject to degradation with time, temperature and exposure to light. The kit contents should be stored in darkness (closed box) at room temperature (18 °C to 28 °C) between uses to ensure the shelf life.

Prior to use, equilibrate the vials in the Vial Block for at least 15 minutes.

5.2.1 To access the Instrument Calibration Menu, respond to the Instrument's prompts as follows:

Main Menu Pipette Calibration?

Press **NO** or **MENU SCROLL**.

Main Menu Instr. Calibration?

Press **YES**. The following prompt will be displayed:

Instrument Cal. Menu Perform Instr. Cal.?

Press **YES** to continue with an instrument calibration.

The instrument will then check the temperature, and if it is outside the specified range for proper operation (18 °C to 28 °C), the following prompt will be displayed:

Temp. out of range Continue? (Y/N)

If **NO** is pressed, the following prompt will be displayed:

Main Menu Pipette Calibration?

If **YES** is pressed to continue with the calibration, there is no certainty that the results the PCS obtains will meet the system specifications.

5.2.2 At the following prompt:

Enter Operator ID: —

Enter a number (not exceeding 20 characters), identifying the operator for this Instrument Calibration. For alphabetic character entry, see Appendix E.

The display will prompt the user to enter the Calibrator Lot Code:

Enter Calibrator Lot Code: _____

The Calibrator Lot Code is found on the label on the inside of the box lid in the Calibrator Kit. It will be a four or five digit number.

After entering the Calibrator Lot Code, press **ENTER**. If this Lot Code matches the one previously entered, proceed to Section 5.2.3.

If the Lot Codes do not match, the display will prompt:

CAL Lot Code XXXXX
New Lot? (Y/N)

If the Lot Code was entered incorrectly, press **NO** and enter the correct Calibrator Lot Code.

If a new lot of reagents is being used, press **YES**. The new calibrator values, which are found on the insert card, will need to be entered. The calibrator values consist of three five-digit numbers and need to be entered only when a new Calibrator Kit is used. The leading zero (if there is one) and the decimal point must be entered. Each group is entered separately. Press **ENTER** after each group of digits. At the next prompt, enter the month and year of the expiration date of the Calibrator Kit as a four digit number (mmyy).

The Instrument will then display:

Lot Code: XXXXX
Correct? (Y/N)

Press **YES** to confirm and to continue with the Instrument Calibration.

5.2.3 After the Calibrator Lot Code is successfully entered, the Instrument will take a series of readings and then prompt:

Insert CAL A Vial

IMPORTANT	The vials in the Instrument Calibrator Kit should always be inserted into the Vial Holder in the same orientation. The labels for these vials should face toward the front of the Instrument, with the vertical lines on the vials facing forward.

Use the CAL A provided in the Instrument Calibrator Kit. Insert it into the Instrument.

When the readings are complete, the Instrument will prompt to remove CAL A, followed by:

Insert CAL B Vial

CAL B, CAL C and CAL D are sequentially inserted, following the prompts. The entire process requires approximately twelve minutes to complete.

When an instrument calibration is successful, the date of the last Instrument Calibration will change to the current day. This date is printed on the footer of subsequent pipette calibration Printouts. If the Instrument fails its calibration, the date will not change. See Appendix B for an example Printout.

NOTE: Refer to Section 7.2, “Troubleshooting Guide,” if the Instrument Calibration fails.

At the completion of the Instrument Calibration the results will be printed (refer to “PCS Printouts”, Appendix B) indicating:

Reading Data

1. Average absorbance reading at 520 nm for each of the four vials (CAL A is used as the zero and hence has a value of zero)
2. Standard deviation of the 520 nm readings for each of the four vials
3. Average absorbance reading at 730 nm for each of the four vials (CAL A is used as the zero and hence has a value of zero)
4. Standard deviation of the 730 nm readings for each of the four vials

Instrument Accuracy

1. The ratio of the CAL sample absorbance at 520 nm to the absorbance at 730 nm for each of the CAL vials B, C, and D
2. The correct value of that ratio as provided by the Calibrator Code
3. The percentage error of the measured ratio
4. A Pass/Fail rating at each absorbance. A Fail rating occurs if the error exceeds 0.75%

Instrument Repeatability

1. The standard deviation of the absorbance readings at each wavelength, for each of the calibrator vials
2. The specification for instrument repeatability at that wavelength for that calibrator vial
3. A Pass/Fail rating at each wavelength for each of the CAL vials. A Fail rating occurs if the standard deviation exceeds the specification

Overall Calibration Result

The overall calibration result is a Pass if each of the previous results was a Pass; it is a Fail if one or more of the previous results was a Fail.

5.3 Instrument Calibration Summary

A printed summary report of the most recent instrument calibration can be obtained, if needed. This summary gives the date, time, and number of the last valid instrument calibration, the operator ID of the person performing the calibration, the calibration kit lot code, and the instrument temperature during the calibration.

5.3.1 To print out an instrument calibration summary, respond to the instrument's prompts as follows:

Main Menu **Pipette Calibration?**

Press **NO** or **MENU SCROLL**.

Main Menu
Instr. Calibration?

Press **YES**.

Instrument Cal. Menu
Perform Instr. Cal.?

Press **NO**.

Instrument Cal. Menu
Print Cal. Summary?

Press **YES**.

The calibration summary will be printed out. See Appendix B for an example Printout.

6.0 INSTRUMENT SETUP

6.1 Instrument Setup Menu

The Instrument Setup Menu is used to access specific setup options.

6.1.1 To access the Setup Menu, respond to the Instrument prompt at the Main Menu with **NO** or **MENU SCROLL**, until the following prompt appears:

Main Menu **Instrument Setup?**

Press **YES**.

6.1.2 The Setup Menu offers the following options:

- Check/Set Date? See Section 6.2
- Check/Set Time? See Section 6.3
- Choose Date Format? See Section 6.4
- Edit Report Hdr 1? See Section 6.5
- Edit Report Hdr 2? See Section 6.5
- Computer Link Flags? See Section 6.6
- Data Collect Flag? See Section 6.7
- Choose Nomenclature? See Section 6.8
- Display Uncertainty? See Section 6.9
- Signature Block? See Section 6.10
- Go to Main Menu?

Use the **MENU SCROLL** key to reach the desired option. Then, press **YES** to initiate the specific setup procedure.

6.1.3 To return to the Main Menu, press **RESET** or **MENU SCROLL** until the following prompt appears:

Go To Main Menu?

Press **YES**.

6.2 Setting Date

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”)

Press **YES** at the prompt:

Check/Set Date?

The following prompt will be displayed:

Correct Date? (Y/N) **mm/dd/yy**

If the date displayed is correct, press **YES**.

If the date is incorrect, press **NO** and enter correct date.

6.3 Setting Time

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”)
Press **YES** at the prompt:

Check/Set Time?

The following prompt will be displayed:

Correct Time? (Y/N) **XX:XX**

If the time displayed is correct, press **YES**.

If the time is incorrect, press **NO** and enter the correct time.

NOTE: The time is displayed in a 24 hour clock format (e.g., noon is 12:00, midnight is 24:00).

6.4 Choosing Date Format

The user can select one of four date formats:

Date Format 1:	dd mm yy	15 AUG 10
Date Format 2:	mm/dd/yy	08/15/10
Date Format 3:	yy-mm-dd	10-08-15
Date Format 4:	yymmdd	100815

Dates appear in the selected format in both the header and footer of the PCS Printouts. The Instrument display will use date format 2 regardless of what is chosen for the printout.

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”) Press **YES** at the prompt:

Choose Date Format?

The following prompt will be displayed:

Date Format: X
Change? (Yes/No)

Press **YES**. The following prompt will be displayed:

Enter New Date Format:

Enter the number (1, 2, 3, or 4) for the date format desired and press **ENTER**.

6.5 Customizing the Printout Header

The two-line header that appears at the top of the Printout can be customized to include such information as the organization name or department.

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”) Press **YES** at the prompt:

Edit Report Hdr 1?

The following prompt will be displayed:

Hdr 1 Edit? (Y/N)

Press **YES**. The following prompt will be displayed:

Hdr 1 Char 1: XX

The two or three digit number XX is the ASCII code for the character in position one and the existing contents of line one of the header appear on the second line of the display. Refer to the ASCII character set (Appendix D) for a listing of the ASCII codes number 32 through 126, any one of which may be employed in the header.

At this time, the first of the twenty characters on the first line may be edited.

If the first character is to be a space, press “3”, then “2”, then **ENTER**. The selected character now appears in the first position of the second display line, and the top line prompts an entry for the second character.

If it is already correct, press **ENTER** to confirm that choice. A character of choice may be replaced by entering the appropriate code number and pressing **ENTER**. Continue in this manner until all characters have been entered for the first line.

Once the first header line is completed, edit the second line in the same way as the first. If the **RESET** key is pressed in the middle of an editing session, the original version of the header is saved, and the instrument will return to the Main Menu.

Once the editing process is complete, the header information is saved in memory for future use. It will remain until altered by a subsequent editing session.

6.6 Computer Link Flags

The Computer Link Flags only have effect when the PCS is operating in the “Linked” mode – that is, when it is controlled by the software in a host PC, such as with ARTEL Pipette Tracker™ software.

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”)

Press **YES** at the prompt:

Computer Link Flags?

The following prompt will be displayed:

Print while Linked Off. Turn On? (Y/N) or **Print while Linked On. Turn Off? (Y/N)**

The Print while Linked flag determines whether or not the PCS will continue to print most pipette calibration results while it is operating "Linked" to a host computer. If a manual Printout on the PCS printer is desired, this flag should be set to ON; if not, it should be set to OFF.

Press **YES** to change the state of the Print while Linked flag. If no change is needed, press **NO**.

The following prompt will be displayed:

Request Missing IDs Off. Turn On? (Y/N or **Request Missing IDs On. Turn Off? (Y/N)**

The Request Missing IDs flag determines whether or not the PCS will request a missing operator ID and/or pipette ID from the operator while it is operating "Linked" to a host computer. If the flag is ON and the host computer is missing either or both of the IDs, the PCS will request it/them from the operator. They can then be included in the Printout (if the Print while Linked flag is ON) and passed back to the host PC as part of the calibration record.

Press **YES** to change the state of the Request Missing IDs flag. If no change is needed, press **NO**.

6.7 Serial Data Output (Data Collect Flag)

There are two ways the PCS can transmit calibration data to a PC over a serial link. The more powerful uses the "Link to Computer" option at the main menu. This option effectively gives control of the PCS to the host PC, and requires that the PC run software capable of controlling the PCS, such as ARTEL Pipette Tracker™ software. The Serial Data Output provides an alternative method for those users who wish to capture calibration data in a PC, but don't want the PC to control the process. When the Serial Data Output is enabled (by setting the Data Collection flag to ON), the PCS will transmit a report to the PC at the end of each calibration.

Note that the Computer Link and Serial Data Output use different

communication formats, and should not be mixed. If the “Link to Computer” option is being used, the Data Collection flag should be turned off.

When the Data Collection Flag is turned on, calibration results are available at the RS232 port on the rear panel of the Instrument (9600 bits per second, 8 data bits, 1 stop bit, no parity) and can be captured by any PC running a suitable communications program.

Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”)

Press **YES** at the prompt:

Data Collect Flag?

To skip this setup option, press **NO**.

If **YES** is pressed, the following prompt will be displayed:

Data Collection: Off
Turn On? (Yes/No)

or

Data Collection: On
Turn Off? (Yes/No)

These prompts relate to the status of the Data Collection setting for the Serial Data Output.

If the status of the Data Collection setting does not need to be changed, press **NO**. The instrument will return to the Setup Menu.

To change the status of the Data Collection setting, press **YES**. The status will change and the instrument will return to the Setup Menu.

IMPORTANT	The Data Collection setting should be turned on only if calibration results are being sent to a PC via the RS232 port. Contact ARTEL for more information about this feature.

6.8 Choose Nomenclature

The summary statistics shown near the end of a PCS pipette calibration can be labeled with one of two different (but equivalent) nomenclatures. The statistics and their labeling are shown below for comparison. The Choose Nomenclature menu entry permits the user to select which choice of nomenclature is desired. As shipped, the PCS is set up with the ARTEL nomenclature.

ARTEL Nomenclature		ISO Nomenclature	
Number of Data Points:	12	Number of Data Points:	12
Mean Volume:	5.063 µL	Mean Volume:	5.063 µL
Absolute Inaccuracy:	0.063 µL	Systematic Error:	0.063 µL
Relative Inaccuracy:	1.26%	% Systematic Error:	1.26%
Standard Deviation:	0.08 µL	Random Error:	0.08 µL
Coef. of Variation (CV):	1.58%	% Random Error:	1.58%

Access this option using the Setup Menu. (Refer to Section 6.1, "Instrument Setup Menu.") See Appendix C for formulas.

Press **YES** at the prompt:

Choose Nomenclature?

The following prompt will be displayed:

Nomenclature: XXX
Change? (Yes/No)

Press **NO** to keep the nomenclature as displayed. Press **YES** to change the nomenclature to the alternative selection. See Appendix B for example of Printout.

6.9 Display Uncertainty (available in version 7A2.2XX or newer firmware)

The Combined Expanded Uncertainty of the mean for each calibration can be calculated by the PCS and displayed on the print out if desired. The calculation is made using data from the calibration including mean volume, %CV, number of data points and standard uncertainties, u_i for each PCS Range Solution. See Appendix C for calculation method. Access this option using the Setup Menu. (Refer to Section 6.1, "Instrument Setup Menu.")

Press **YES** at the prompt:

Display Uncertainty?

To skip this setup option, press **NO**.

If **YES** is pressed, the following prompt will be displayed:

Uncertainty: Omit Change? (Yes/No)	or	Uncertainty: Include Change? (Yes/No)

These prompts relate to the status of the Uncertainty setting for the Printout.

Press **NO** to keep the Uncertainty as displayed. Press **YES** to change the Uncertainty to the alternative selection. See Appendix B for an example Printout.

6.10 Signature Block (available in version 7A2.1XX or newer firmware)

The Signature Block menu entry allows the display “Performed By:” and “Reviewed By:” signature lines to appear on the Printout. Each line will also contain a “Date:” section for recording the date. Access this option using the Setup Menu. (Refer to Section 6.1, “Instrument Setup Menu.”)

Press **YES** at the prompt:

Signature Block?

To skip this setup option, press **NO**.

If **YES** is pressed, the following prompt will be displayed:

Sig block: Omit Change? (Yes/No)	or	Sig block: Include Change? (Yes/No)

These prompts relate to the status of the Signature Block setting for the Printout.

Press **NO** to keep the Signature Block as displayed. Press **YES** to change the Signature Block to the alternative selection. See Appendix B for an example Printout.

7.1 Instrument Diagnostics Menu

The Diagnostics Menu is used to access specific systems performance checks. These diagnostics are useful when performed in conjunction with the corrective action outlined in the Troubleshooting Guide, or when working with Artel Technical Support. Contact Technical Support at 888-406-3463.

7.1.1 Access the Diagnostics Menu at the Main Menu by pressing **NO** or **MENU SCROLL**, until the following prompt appears:

Main Menu **Instr. Diagnostics?**

Press **YES**.

7.1.2 The Diagnostics Menu offers the following options:

- Instr. Serial No.? — This entry is simply for convenience to display the instrument serial number without turning the instrument over (the instrument serial number is on a label on the bottom of the instrument), or searching for a Printout (it is near the bottom of most Printouts).

- Software Ver. No.? — This entry is also for convenience to determine the software version number without removing the back cover (the software version number is on a label on the program memory card), or searching for a Printout (it is near the bottom of most Printouts).

- Hdw. Config. Code? — This entry will only appear if the instrument has *factory installed* firmware version 7A2.200 or later. It displays information regarding the instrument hardware configuration in four two-character blocks separated by dashes (e.g. XX-XX-XX-XX). Knowing the Hardware Configuration Code will help Artel Technical Support personnel in diagnosing an instrument problem.

- Test Lamp? — This entry allows the user to determine: (a) if the lamp and driving circuitry are operating properly, and (b) if the instrument filters are in

good condition. When this entry is selected, choose the filter through which the lamp light will pass (520 nm or 730 nm) as part of the lamp voltage stabilization.

If both lamp voltages are stable and below 3.5 volts, the lamp is operating properly. If a problem with the filters is suspected, ARTEL Technical Support can provide assistance through this diagnostic function.

- Test Mixer? — This entry determines if the mixer is clear of obstructions and operating properly. It will mix a sample for approximately five seconds and display an error message if any problems are encountered.

- Test Filter Wheel? — This entry determines if the filter wheel is able to select the filters properly. It will allow a selection of one of two filters (520 nm or 730 nm). If the filter wheel cannot be positioned to the selected filter, an error message will be displayed.

- Read Temperature? — This entry displays the PCS temperature as determined by the probe in the vial block.

NOTE: Should the probe be disconnected (as might happen if the rear access cover is removed for instrument service and not properly re-installed), the PCS will beep at power-on and indicate that there is a temperature probe error.

- Test Switches? — This entry checks the lid open/closed switch and the vial-in-place sensor. Failure of either sensor will make it impossible to use the PCS normally.

- Go to Main Menu? — Use **MENU SCROLL** to reach the desired option. Then, press **YES** to initiate the specific diagnostic procedure.

7.1.3 To return to the Pipette Calibration Procedure press **RESET** or **MENU SCROLL** until the following prompt appears:

Diagnostics Menu **Go to Main Menu?**

7.1.4 Press **YES**. The instrument will return to the following prompt:

Main Menu **Pipette Calibration?**

7.2 Troubleshooting Guide

The Troubleshooting Guide is an aid to identifying symptoms observed while operating the PCS, understanding probable causes, and suggesting corrective action.

If a problem cannot be resolved by following these instructions, please call Artel Technical Support at 888-406-3463 for assistance.

Symptom	Cause	Corrective Action
No display during Power-On	Power Supply not plugged into Instrument.	Plug Power Supply into Instrument.
	Power Cord not plugged into Power Supply.	Plug Power Cord into Power Supply.
	Power Cord not plugged into grounded AC outlet.	Plug Power Cord into grounded AC outlet.
Error Message: “Bad CAL A remove Vial”	Improper vial inserted.	Ensure that CAL A vial is inserted.
Error Message: “ERROR-13” “Check Temp Sensor”	Temperature sensor to Vial Block disconnected.	Remove Rear Access Cover and reconnect sensor. Refer to Section 8.3, “Removal of Rear Access Cover.”
Error Message: “Invalid Blank Rdg.”	Wrong vial inserted or Blank out of specification	Ensure that an unused Blank Vial is inserted, and expiration date of kit is not exceeded.
Failed Instrument Calibration	Vials not adequately clean/dry before equilibrating in the Vial Block.	Gently clean vials with a lint-free wipe and place in Vial Block for 15 minutes.
	Kit not fully equilibrated to room temperature.	The kit should be allowed to adequately equilibrate to room temperature, and the vials allowed to equilibrate in the Vial Block for at least 15 minutes prior to use.
	Vials not inserted into the Vial Holder in the proper orientation.	The vertical line on the labels for these vials should face toward the front of the Instrument.
	Bubbles in vial due to excessive shaking directly prior to insertion into Vial Holder.	Allow bubbles to disperse before performing calibration.
Error Message: “PRINTER ERROR” Retry? Yes/No	Printer cable not properly connected.	Check Printer cable connections.
		Plug in AC adapter. The AC adapter should always be plugged into printer when in use.

7.2 Troubleshooting Guide (continued)

Symptom	Cause	Corrective Action
Error Message: "Mixer Failure Press Any Key"	Vial hitting Vial Holder Cover, due to Vial not inserted completely in Vial Holder or cap not removed from Vial.	Make certain vial is inserted completely in Vial Holder and the cap is removed.
	Obstruction prevents Vial Holder from moving freely from side to side.	Remove gray shield, and Rear Access Cover if needed. Find and remove obstruction. Refer to Section 8.3, "Removal of Rear Access Cover."
	Component failure	Call Artel Technical Support for assistance.
Error Message: "ERROR-16 FILTER WHEEL ERROR"	Filter wheel sensor not detecting wheel properly.	Call Artel Technical Support for assistance.
Error Message: "READING ERROR RETRY (Y/N)"	Bad A/D reading	If after second retry, error message persists, turn Instrument and printer power switches off for 1 minute or longer, then power back on. If the problem still persists, call Artel Technical Support for assistance.
Error Message: "Invalid volume! Re-enter? Yes/No"	Volume is outside the specified pipette volume range that the PCS is capable of calibrating.	The PCS can calibrate pipettes from 0.1 µL through 5000 µL.
Message: "Waiting for Data Collection Prompt"	The Data Collection output has been turned on. The Instrument is waiting for a signal from a PC to send calibration results via the RS232 port.	If calibration results are not being sent to a PC via the RS232 port, press **CLEAR**. To turn off the Data Collection output. Refer to Section 6.7, "Serial Data Output (Data Collect Flag)."

This Page Intentionally Left Blank

8.0 SYSTEM MAINTENANCE

8.1 Preventive Maintenance

The PCS Instrument requires minimal operator maintenance. However, periodic cleaning procedures should be performed. The operator, depending upon the condition of the working environment, should determine the frequency of maintenance.

8.1.1 Cleaning the Cabinet

To clean the cabinet, use only a clean water-dampened cloth. If the bores of the vial block need cleaning, use damp cotton swabs.

8.2 Instrument Calibration

Follow the procedure described in Section 5.0, “Instrument CAL A and Calibration”

8.3 Removal of Rear Access Cover

The Rear Access Cover can be removed from the PCS Instrument. Removing the cover permits access to the user replaceable PROM card.

CAUTION!	Disconnect all external cabling. Prior to removal of cover components the power must be turned off and the external Power Supply unplugged from the Instrument.

8.3.1 Locate and unfasten the two (2) quarter-turn fasteners on the Rear Access Cover. To unfasten the quarter-turn fasteners, use a screwdriver, insert the blade in the slot and rotate 1/4 turn counter clockwise. The fastener will pop out 1/4 inch, indicating an unfastened condition.

IMPORTANT:	The Vial Block on the Rear Access Cover has a cable that is attached via a connector to the main circuit board. If the connector becomes disconnected, reconnect prior to replacing the Rear Access Cover onto the Instrument.

8.3.2 Remove the Rear Access Cover and place directly behind PCS Instrument.

8.3.3 To replace the Rear Access Cover onto the Instrument, align the top tabs with the cabinet. Push in the quarter-turn fasteners and turn them clockwise until the fasteners are inserted and secure.

8.4 Maintenance Log Sheet

PCS® S/N_____

Date	Maintenance Performed	Next Scheduled Maintenance	Signature

This Page Intentionally Left Blank

9.0 WARRANTY AND SERVICE

9.1 Warranty Statement

The PCS® Instrument is warranted to perform as described in its labeling and in Artel literature, when used in accordance with its instructions, for a period of one year from the date of shipment of the Instrument.

ARTEL MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED AND DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR PARTICULAR PURPOSE.

Artel's sole obligation and purchaser's exclusive remedy for breach of this warranty, at Artel's option, shall be to repair or replace the Instrument, provided the purchaser notifies Artel promptly. IN NO EVENT SHALL ARTEL BE LIABLE FOR ANY PROXIMATE, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

This warranty is voided by alteration, repair or modification of the Instrument by any party other than Artel, except for maintenance procedures performed as shown in the Instrument's instructions.

9.2 Return and Repair

9.2.1 To return products to Artel for warranty repair, non-warranty repair, or recertification, contact the Artel Technical Support Department. A Return Goods Authorization (RGA) number will be issued for all returns.

Telephone:	Local: 207-854-0860 Toll Free: 888-406-3463
Ship to:	Artel 25 Bradley Drive Westbrook, ME 04092-2013

9.2.2 To ensure protection of the Instrument during shipment, the original packaging should be used. If the original packaging is not available, Artel can supply packaging material upon request. Products should also be insured against damage during shipment. Artel is not responsible for any damage to products incurred during shipment to Artel.

This Page Intentionally Left Blank

APPENDIX A
SPECIFICATIONS

PCS®2 INSTRUMENT

Size	22.8 cm (9.0 in) W x 11.6 cm (4.6 in) H x 30.4 cm (12.0 in) D
Weight	4.8 kg (10.5 lbs.)
Keypad	18 keys
Display	2 x 20 alphanumeric
Wavelengths	520 nm and 730 nm
Printer Output	Centronics Parallel
Serial Input/Output	RS 232 (configuration: 9600 bits per second, 8 data bits, 1 stop bit, no parity).
Noise	Less than 0.00015 AU at AU = 1
Inaccuracy	Less than 0.75% over the range 0 to 1.5 AU

SYSTEM PERFORMANCE

Assay Time Requirement	Three minutes for a ten data point calibration.
Data Points Per Assay	1 to 50 data points can be taken per calibration.
Inaccuracy	Less than 1%
Imprecision	Less than 0.5% CV
Operating Temperature	18 °C to 28 °C
Printed Output	Calibration data record; 11.2 cm width; with standard printer supplied.

PCS REAGENTS AND STANDARDS

Blank Solution Vials

Absorbance	Maximum near 730 nm
Shelf Life and Storage	Maximum of 10 months at 18 °C to 28 °C, closed box, out of direct sunlight

Sample Solutions (Ranges 1 through 6)

Absorbance	Maximum near 520 nm
Shelf Life and Storage	Maximum of 10 months at 18 °C to 28 °C, closed box, out of direct sunlight

Calibration Standards (Vials A, B, C and D)

Absorbance	Maxima near 520 nm and 730 nm
Shelf Life and Storage	Maximum of 13 months at 18 °C to 28 °C, closed box, out of direct sunlight

Use only Artel certified Blank Solution Vials, Sample Solutions and Calibration Standards.

U.S. Patents	5,492,673; 5,298,978; 7,772,008; 7,791,716
European Patents	EP0628157; EP0711404
Japanese Patent	2520852

This Page Intentionally Left Blank

APPENDIX B
PCS PRINTOUTS

Sample PCS Instrument Calibration Check Printout

(Your Lab's Name)

Date: 01 Jun 2011
Time: 15:03

PCS INSTRUMENT CALIBRATION CHECK

Operator ID: 39
Cal Kit Lot Code: 39341

READING DATA

Cal	520 nm Avg Abs	520 nm Std Dev	730 nm Avg Abs	730 nm Std Dev
A	0.0000	0.00005	0.0000	0.00002
B	0.5019	0.00006	0.4959	0.00002
C	0.9926	0.00008	0.9878	0.00004
D	1.4789	0.00004	1.4798	0.00006

INSTRUMENT ACCURACY

Cal	520/730 Ratio	Cal Kit Ratio	% Error	Result
B	1.0121	1.0122	0.00%	Pass
C	1.0049	1.0050	-0.01%	Pass
D	0.9994	0.9985	0.09%	Pass

Spec. (all 3 cases): +/- 0.75%

INSTRUMENT REPEATABILITY

520 nm:

Cal	Std Dev	Spec.	Result
A	0.00005	0.00018	Pass
B	0.00006	0.00016	Pass
C	0.00008	0.00023	Pass
D	0.00004	0.00050	Pass

730 nm:

Cal	Std Dev	Spec.	Result
A	0.00002	0.00050	Pass
B	0.00002	0.00050	Pass
C	0.00004	0.00050	Pass
D	0.00006	0.00050	Pass

OVERALL CALIBRATION RESULT: PASS

Temperature: 21.2 C

Instrument Cal. Number: 105
Instrument Serial No.: 8282
Software Version: PCS 7A2.203

ARTEL PCS PIPETTE CALIBRATION SYSTEM

Patents:
USA: 5492673, 5298978, 7772008, 7791716
Europe: EP0711404, EP0628157
Japan: 2520852

Sample PCS Instrument Calibration Summary Printout

```
            (Your Lab's Name)


Date:  01 Jun 2011
Time:  15:38

  PCS INSTRUMENT CALIBRATION SUMMARY

Instr. Cal. Date:   02 Sep 10
Instr. Cal. Time:   15:03
Instr. Cal. Number: 105

Cal. Operator ID:   39
Cal. Kit Lot Code:  39341
Cal. Temperature:   21.2 C

Calibration Result: Pass

Instrument Serial No.:   8282
Software Version:        PCS 7A2.203

  ARTEL PCS PIPETTE CALIBRATION SYSTEM

Patents:
USA: 5492673, 5298978, 7772008, 7791716
Europe: EP0711404, EP0628157
Japan: 2520852
```

Sample Pipette Calibration Printout
(Artel Nomenclature)
(Optional Uncertainty Included)
(Optional Signature Block Included)

```
          (Your Lab's Name)


Date:  01 Jun 2011
Time:  15:18

         PIPETTE CALIBRATION

Pipette ID:        67443
Operator ID:       39
Reagent Lot Code:  18356


Pipette Sample Volume:  20.00 uL
Sample Solution Range:  3

    SAMPLE #      VOLUME
       1          20.06
       2          20.00
       3          20.05
       4          20.10
       5          20.08
       6          20.10
       7          20.07
       8          20.12
       9          20.16
      10          20.09

Number of Data Points:   10
Mean Volume:             20.08 uL
Absolute Inaccuracy:     0.08 uL
Relative Inaccuracy:     0.41 %
Standard Deviation:      0.043 uL
Coef. of Variation (CV): 0.21 %
Uncertainty of Mean,k=2: 0.1200 uL

Temperature:             21.2 C

Last Instr. Cal. Date:   01 Jun 2011
Last Instr. Cal. No.:    105
Instrument Serial No.:   8282
Software Version:        PCS 7A2.203

_____________________    _________
    Performed by             Date

_____________________    _________
    Reviewed by              Date


  ARTEL PCS PIPETTE CALIBRATION SYSTEM

Patents:
USA: 5492673, 5298978, 7772008, 7791716
Europe: EP0711404, EP0628157
Japan: 2520852
```

Sample Pipette Calibration Printout
(ISO Nomenclature)
(Optional Uncertainty Omitted)
(Optional Signature Block Omitted)

```
          (Your Lab's Name)


Date: 01 Jun 2011
Time:  15:18

         PIPETTE CALIBRATION

Pipette ID:        67443
Operator ID:       39
Reagent Lot Code:  18356


Pipette Sample Volume:  20.00 uL
Sample Solution Range:  3

    SAMPLE #      VOLUME
       1          20.06
       2          20.00
       3          20.05
       4          20.10
       5          20.08
       6          20.10
       7          20.07
       8          20.12
       9          20.16
      10          20.09

Number of Data Points:   10
Mean Volume:             20.08 uL
Systematic Error:        0.08 uL
% Systematic Error:      0.41 %
Random Error:            0.043 uL
% Random Error:          0.21 %

Temperature:             21.2 C

Last Instr. Cal. Date:   01 Jun 2011
Last Instr. Cal. No.:    105
Instrument Serial No.:   8282
Software Version:        PCS 7A2.203

  ARTEL PCS PIPETTE CALIBRATION SYSTEM

Patents:
USA: 5492673, 5298978, 7772008, 7791716
Europe: EP0711404, EP0628157
Japan: 2520852
```

Sample Pipette Calibration Printout for Multiple Volumes on Variable Volume Pipette

Header

Results for first volume

Statistical Summary for first volume

Results and Statistical Summary Repeated for Each Additional Volume

Statistical Summary

Footer

```
            (Your Lab's Name)


Date:  01 Jun 2011
Time:  15:25

           PIPETTE CALIBRATION

Pipette ID:        67443
Operator ID:       39
Reagent Lot Code:  18356


Pipette Sample Volume:  20.00 uL
Sample Solution Range:  3

      SAMPLE #      VOLUME
         1          20.06
         2          20.00
         3          20.05
         4          20.10
         5          20.08
         6          20.10
         7          20.07
         8          20.12
         9          20.16
        10          20.09

Number of Data Points:   10
Mean Volume:             20.08 uL
Absolute Inaccuracy:     0.08 uL
Relative Inaccuracy:     0.41 %
Standard Deviation:      0.043 uL
Coef. of Variation (CV): 0.21 %

Temperature:             21.2 C


Pipette Sample Volume:  50.00 uL
Sample Solution Range:  2

      SAMPLE #      VOLUME
         1           50.16
         2           50.07
         3           50.12
         4           50.21
         5           50.08
         6           50.12
         7           50.26
         8           50.18
         9           50.09
        10           50.22

Number of Data Points:   10
Mean Volume:             50.15 uL
Absolute Inaccuracy:     0.15 uL
Relative Inaccuracy:     0.30 %
Standard Deviation:      0.065 uL
Coef. of Variation (CV): 0.13 %

Temperature:             21.3 C


Last Instr. Cal. Date:   01 Jun 2011
Last Instr. Cal. No.:    105
Instrument Serial No.:   8282
Software Version:        PCS 7A2.203

  ARTEL PCS PIPETTE CALIBRATION SYSTEM

Patents:
USA: 5492673, 5298978, 7772008, 7791716
Europe: EP0711404, EP0628157
Japan: 2520852
```

APPENDIX C
FORMULAS USED TO CALCULATE GROUP STATISTICS

Mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Standard Deviation

$$STD = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2}{n-1}}$$

Coefficient of Variation

$$\%CV = \frac{STD}{\bar{x}} \times 100$$

Inaccuracy

$$INACC = \frac{\left(\bar{x} - \text{nominal volume}\right)}{\text{nominal volume}} \times 100$$

Combined Expanded Uncertainty of the mean, k =2

$$U = 2 \times \sqrt{\left(u_i \times \bar{x}\right)^2 + \left(\frac{STD}{\sqrt{n}}\right)^2}$$

Standard Relative Uncertainties for PCS Ranges 1 through 6:

u_1=0.5%	u_4=0.3%
u_2=0.4%	u_5=0.3%
u_3=0.3%	u_6=0.3%

(n is the number of data points)

This Page Intentionally Left Blank

APPENDIX D
ASCII CHARACTER SET

Code	Character	Code	Character	Code	Character	Code	Character
32	(space)	56	8	80	P	104	h
33	!	57	9	81	Q	105	i
34	“	58	:	82	R	106	j
35	#	59	;	83	S	107	k
36	$	60	<	84	T	108	l
37	%	61	=	85	U	109	m
38	&	62	>	86	V	110	n
39	‘	63	?	87	W	111	o
40	(	64	@	88	X	112	p
41	)	65	A	89	Y	113	q
42	*	66	B	90	Z	114	r
43	+	67	C	91	[	115	s
44	,	68	D	92	\	116	t
45	-	69	E	93	]	117	u
46	.	70	F	94	^	118	v
47	/	71	G	95	_	119	w
48	0	72	H	96	`	120	x
49	1	73	I	97	a	121	y
50	2	74	J	98	b	122	z
51	3	75	K	99	c	123	{
52	4	76	L	100	d	124	|
53	5	77	M	101	e	125	}
54	6	78	N	102	f	126	~
55	7	79	O	103	g		

This Page Intentionally Left Blank

APPENDIX E
ALPHABETIC CHARACTER ENTRY

To enter a letter at either the Enter Operator ID prompt or the Enter Pipette ID Number prompt press **MENU SCROLL**.

Letter Entry Display

At the Letter Entry display, the carat (**^**) indicates which letter is to be entered. Using the "4" or the "6" key will move the carat left or right until it is beneath the letter to be entered. Press **ENTER** to select the desired letter.

Note that the "4" and "6" keys are "typematic"; that is, their action will repeat as long as they are held down.

Three other keys can be used to speed up the letter selection:

Key	Function
1	Moves the carat to the letter "A".
2	Moves the carat to the letter "M".
3	Moves the carat to the letter "Z".

The "1" and "3" keys speed up the selection of letters near the beginning or the end of the alphabet, respectively. The "2" key returns the carat to the middle of the alphabet.

To return to either the Enter Operator ID prompt or the Enter Pipette ID Number prompt, with the selected letter, press **ENTER**. To return without selecting a letter, press **CLEAR**.

This Page Intentionally Left Blank

APPENDIX F
NUMBER OF SAMPLES PER VIAL

PCS Range Solutions	Pipette Volume	7A2.103 or earlier Number of Samples	7A2.2XX Approximate Number of Samples
Range 1 60 mL Bottle 200 - 5000 µL	200	22	27
	211	22	26
	220	22	25
	229	22	24
	239	22	23
	258	21	21
	270	20	20
	284	19	19
	299	18	18
	315	17	17
	334	16	16
	355	15	15
	378	14	14
	405	13	13
	436	12	12
	473	11	11
	516	10	10
	567	9	9
	630	8	8
	709	7	7
	810	6	6
	945	5	5
	1134	4	4
	1417	3	3
	1889	2	2
	5000	1	1
Range 2 60 mL Bottle 50 - 199 µL	50	22	40
	59	22	39
	61	22	38
	63	22	37
	64	22	36
	66	22	35
	68	22	34
	70	22	33
	72	22	32
	74	22	31
	77	22	30
	79	22	29
	82	22	28
	85	22	27
	88	22	26
	91	22	25
	95	22	24
	99	22	23
	103	22	22
	104	21	22
	108	20	21
	114	19	20
	120	18	19
	126	17	18
	134	16	17
	142	15	16
	152	14	15
	157	13	15
	162	12	14
	189	11	12
	199	11	11

PCS Range Solutions	Pipette Volume	7A2.103 or earlier Number of Samples	7A2.2XX Approximate Number of Samples
Range 3 60 mL Bottle 10 - 49 µL	10	22	40
	15	22	37
	16	22	35
	17	22	33
	18	22	31
	19	22	29
	20	22	28
	21	22	27
	22	22	25
	23	22	24
	24	22	23
	25	22	22
	26	21	21
	27	20	21
	28	20	20
	29	19	19
	30	18	18
	32	17	17
	34	16	16
	36	15	15
	38	14	14
	41	13	13
	44	12	12
	48-49	11	11
Range 4 60 mL Bottle 2 - 9 µL	2	22	40
	3	22	37
	4	22	28
	5	22	22
	6	18	18
	7	16	16
	8	14	14
	9	12	12
	9.9	11	11
Range 5 60 mL Bottle 0.5 - 1.9 µL	0.5	22	40
	0.6	22	37
	0.7	22	32
	0.8	22	28
	0.9	22	25
	1	22	22
	1.1	20	20
	1.2	18	18
	1.3	17	17
	1.4	16	16
	1.5	15	15
	1.6	14	14
	1.7	13	13
	1.8	12	12
	1.9	11	11
Range 6 60 mL Bottle 0.1 - 0.49 µL	0.1	22	40
	0.15	22	37
	0.2	22	28
	0.25	20	22
	0.3	18	18
	0.35	16	16
	0.4	14	14
	0.49	12	11

This Page Intentionally Left Blank

ARTEL PCS®
Pipette Calibration System
Consumables List

CATALOG NO.	NAME	DESCRIPTION
PCS-200	PCS Standard Reagent Kit	• 12 Blank Vials • 1 zero calibrator • aliquot containers • transfer pipettes • Sample Solution for Ranges 1, 2, 3, & 4
PCS-210	PCS Bulk Reagent Kit (customizable)	• 50 Blank Vials • 1 zero calibrator • aliquot containers • transfer pipettes • Sample Solution for Ranges 1, 2, 3, & 4
PCS-211	PCS NP Bulk Kit	• PCS-210 without transfer pipettes and aliquot containers
PCS-221	PCS R1 Sample Solution	• Sample Solution for Range 1 (for pipette volumes 200 to 5000 µL)
PCS-222	PCS R2 Sample Solution	• Sample Solution for Range 2 (for pipette volumes 50 to 199 µL)
PCS-223	PCS R3 Sample Solution	• Sample Solution for Range 3 (for pipette volumes 10 to 49.9 µL)
PCS-224	PCS R4 Sample Solution	• Sample Solution for Range 4 (for pipette volumes 2 to 9.9 µL)
PCS-225	PCS R5 Sample Solution	• Sample Solution for Range 5 (for pipette volumes 0.50 to 1.99 µL)
PCS-226	PCS R6 Sample Solution	• Sample Solution for Range 6 (for pipette volumes 0.1 to 0.499 µL)
PCS-600	PCS Instrument Calibrator Kit	• 4 calibrator vials
PCS-700	Paper for Printer (Thermal)	• 5 rolls
PCS-710	Paper for Printer (Impact)	• 12 rolls
PCS-410	Calibration Certificate	• For PCS Instrument
PCS-415	Calibration Certificate	• For PCS Calibrator Kit
PCS-805	PCS Instrument Dust Cover	• Protective Dust Cover with Artel Logo

This Page Intentionally Left Blank